THE CLASSIFICATION OF THE PUPÆ OF THE SATURNIIDÆ.*

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A short discussion of the characters of the pupæ of the superfamily Saturnioidea was given in a preceding paper, Annals Entomological Society of America, Vol. VII, pp. 277-8, including a key for the separation of the three families. Two of the families, the Ceratocampidæ and Hemileucidæ were discussed in that paper, and the third, the Saturniidæ, will be considered here. Plate V, included in this paper shows some of the more important structures of the Ceratocampidæ and Hemileucidæ.

The general characters of the family Saturniidæ are as follows: Body with abdominal segments 5 to 7 capable of being telescoped, antennæ broadly pectinate throughout, or nearly so, the stem of the flagellum distinct and raised above the level of the pectinations, varying greatly in the sexes, always broader and usually longer in the male; maxillæ, measured on the meson,† never more than one-third the length of the wings; the exposed portion of the tibiæ and tarsi of the first pair of legs, and the tips of the second pair of legs with their lateral margins adjacent on the meson, never with the distal ends of the tarsi of the first and second pairs of legs meeting obliquely on the meson; first pair of wings with the anal angles broadly rounded, and always reaching the caudal margin of the fourth abdominal segment on the ventral surface; second pair of wings produced around the anal angles of the first pair of wings and usually forming prominent angles on the fourth abdominal segment, always extending at least a short distance along the ventral margin of the first pair of wings; metathorax without distinct oblong tubercles one-third or more the width of the segment; suture between the seventh and eighth abdominal segments never deep with distinct crenulations on its margins; distinct cremaster never present; pupæ always found in cocoons.

Of the family Saturniidæ, the pupæ of eight genera have been described in the following pages. They may be separated by the following key:

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†The maxillæ are measured from the distal margin of the labrum to their distal end (Fig. 14, a, b). The wings are measured from the same point to their caudal margin (Fig. 14, a, c).

A. Body never cylindrical, but tapering gradually from the middle as in Fig. 13, the lateral margins of the movable segments never approximately parallel; caudal end of body usually with stout curved spines.

B. Tenth segment never flattened into a transverse plate, with the caudo-lateral angles produced into short lobes.

C. Caudal end of body without spines; body surface with slightly wavy, transverse ridges, with distinct furrows between; mesothorax never with a prominent tubercle at the base of each wing. *Copaxa.*

CC. Caudal end of body with stout, curved spines; body surface never with slightly wavy, transverse ridges with distinct furrows between; mesothorax with a prominent tubercle at the base of each wing.

D. Lateral aspects of the cephalic margins of abdominal segments 5 to 7 never with sharp, slightly wavy, transverse ridges with distinct furrows between; caudal end of body with an oval area set with slightly curved spines, usually arranged in two groups and nearly all pointing outwards. *Telea.*

DD. Lateral aspects of the cephalic margins of abdominal segments 5 to 7 covered with sharp, slightly wavy, transverse ridges with distinct furrows between; caudal end of body deeply rugose, with a slight concavity containing a circular group of strongly recurved spines. *Tropaea.*

BB. Tenth segment, viewed dorsally, a transverse plate, concave on the caudal margin, the caudo-lateral angles produced into lobes, the segment strongly concave in ventral view, with five short, curved spines inserted close together in the caudo-lateral margin of each lobe. *Agapema.*

AA. Body cylindrical in outline, as in Fig. 14, the lateral margins of the movable segments approximately parallel; caudal end of the body never with stout curved spines, but sometimes with short, straight ones.

B. Maxillae, measured on the meson, always one-fourth or less the length of the wings, the proximal two-thirds of their margins never strongly concave; first pair of wings with their anal angles on the cephalic margin of the fourth abdominal segment or caudad of that portion of the segment.

C. Maxillae, measured on the meson, less than one-fifth the length of the wings; antennae of males with the sides tapering gradually to a pointed tip.

D. Both eye-pieces never visible in either sex; caudal end of abdomen never with a band of coarse setae, sometimes with a few very short, straight spines.

E. Glazed eyepiece visible in both sexes; caudal end of abdomen with a few very short, straight spines. *Eupackardia.*

EE. Glazed eyepiece never visible in either sex; caudal end of abdomen never with short, straight spines. *Callosamia.*

DD. Both eyepieces visible in either sex; caudal end of abdomen with a transverse band of coarse setae. *Rothschildia*

CC. Maxillae, measured on the meson, never less than one-fifth the length of the wings; antennae of males with the sides approximately parallel for the greater part of their length, tapering rapidly to a blunt, rounded tip; a small portion of glazed eyepiece always visible in the females. *Samia.*

BB. Maxillae, measured on the meson, always more than one-fourth the length of the wings; the proximal two-thirds of the lateral margins of the maxillae concave; first pair of wings with their anal angles on the third abdominal segment, opposite the second pair of abdominal spiracles. *Philosamia.*

Genus **Copaxa** Walker.

Body tapering at cephalic end; face parts scarcely elevated above the surface of the body; antennæ pectinate throughout, the stem of the flagellum slightly elevated above the pectinations; glazed eye-piece visible in the female; invaginations for the anterior arms of the tentorium distinct; clypeo-labral suture distinct; maxillæ, measured on the meson, about one-seventh the length of the wings; tarsi of the first pair of legs adjacent on the margin in the female, covered by the antennæ in the male; second pair of legs not visible; median thoracic line distinct, sometimes elevated on the prothorax, faint on the mesothorax and metathorax; caudal part of mesonotum and metanotum not depressed adjacent to wings; wings with their distal margins slightly elevated above the dorsal surface of the body; first pair of wings with their anal angles broadly rounded; second pair of wings visible around the entire dorsal margin of first wing and produced below the anal angle to form a prominent angle opposite the third abdominal spiracle, but not reaching the caudal margin of the fourth abdominal segment; abdominal segments 8 to 10 distinctly segmented, tapering rapidly to form a cone.

This genus is found in Mexico and southward. The cocoons are brown, composed of two layers and are much like those of *Agapema galbina*. The outer layer is very thin and coarsely reticulate, usually attached to a leaf. The inner layer is much thicker, finely reticulate, and the cocoon has an opening at the end, with loose fibers for the emergence of the moth.

Copaxa lavendera Westwood.— Color variable, usually yellowish brown to black, marked with darker brown, or dark brown to black, with traces of yellowish brown; face parts with fine, indeterminate longitudinal striations, appendages and wings with indeterminate transverse striations, remainder of body surface with slightly wavy, interrupted ridges, mostly transverse, with distinct furrows between; antennæ of male slightly raised above the level of the wings, the length about two and three-quarters times the width, the sides approximately parallel for the greater part of the length, tapering to a point at distal end and lying adjacent on the margin for a distance equal to its width; antennæ of female not raised above the level of the wings, the length three and one-half times the width, tapering to a point at the distal end, the tips meeting on the meson over the tips of the first pair of legs; labrum variable, the width a little greater than the length, usually five or six sided, slightly tuberculate, and broadly rounded or slightly bilobed at the distal end; maxillæ triangular in outline or somewhat heart-shaped, the median length slightly less than the greatest width; spiracles free. Length, abdomen retracted, 30-32 mm., expanded, 33-35 mm., girth, 38-45 mm.

Genus **Telea** Hübner.

Body blunt at cephalic end; abdominal segments 1 to 4 rounded out above the margin of the body dorsad and forming a distinct hump, segments 5 to 7 distinctly decreasing in size and caudal margin of segment seven joining cephalic margin of segment eight with only a slight indentation between; antennæ pectinate throughout, varying greatly with the sexes, the stem of the flagellum in both always less than one-third the total width; eye-pieces not visible; invaginations for the anterior arms of the tentorium distinct; clypeo-labral suture distinct; maxillæ, measured on meson, about one-fourth length of wings; legs in the male covered by antennæ, in the female tarsi of first pair and tips of second pair adjacent on the meson; median thoracic line carinate on all segments; mesothorax with a prominent tubercle at base of wings;* caudal part of mesonotum and metanotum depressed adjacent to the wings; wings with their distal margin raised above the dorsal surface of body; dorsal cephalic margins of abdominal segments 5 to 7 form a heavy raised line extending laterad and cephalad of the spiracles to the proleg scars on the ventral surface; abdominal segments 7 to 10 tapering rapidly, forming an oblique convex cone-shaped piece; tip of abdomen with a small oval area set with fifteen or more stout, black, slightly curved

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*Mesothoracic tubercles are found in the pupae of many genera, but are especially prominent in the case of *Tropaea luna* and *Telea polyphemus* (Fig. 11, w. t.), where at the proximal ends of the wings they differed so much in shape and size from any others noticed in the study of pupae, that they were investigated and each found to contain a prominent spine. This spine is used to cut the cocoon to allow the imago to escape and was found in the imagos of all genera of Saturniidæ studied, but especially well developed in the genera previously mentioned. A study of the preimago showed that this spine was an outgrowth from one of the wing sclerites, the third axillary of Snodgrass. In *Telea polyphemus* (Fig. 12), there is also a smaller spine cephalad of the large one.

spines, usually arranged in two small groups and nearly all pointing outwards.

This genus consists of a single species, *Telea polyphemus*, found in all parts of the United States. Their cocoons consist of a thick, firm layer, never "papery," like those of *Tropaea luna*. The cocoons are pale grayish tan in color, ovoid in shape, blunt at the ends and usually fastened between two leaves. It never has an opening at the end with loose fibers across it, as many cocoons have. It is found suspended from twigs where it often fastens the leaf to a tree and is also found on the ground among the fallen leaves.

Telea polyphemus Cramer (Figs. 11 and 13).—Color yellowish brown, with darker brown around margins of spiracles, and appearing at various places on surface as the age increases; face parts not elevated, always white between the antennæ, the white strip narrowing down to the proximal margin of the labrum and concave on its lateral margins; prothorax and mesothorax with faint transverse striations, remainder of body surface smooth, with the exception of longitudinal wrinkles on the metathorax and first abdominal segment and some slight dorsal impressions; antennæ of male five-sixths the length of wings on the meson, length twice the width; meeting on the meson for more than half their length; antennæ of the female two-thirds the length of wings on the meson, length three times the width, separated by the legs and ending slightly below tips of the first pair; labrum variable, tuberculate, generally five or six sided, the distal margin either slightly or deeply bilobed; maxillæ triangular in outline, the mesal length greater than greatest width; mesothorax with wing tubercles prominent, broadly elevated, with a distinct apex marked by an angular furrow on the caudo-mesal margin; first wing with its anal angle broadly rounded, below cephalic margin of fourth abdominal segment; margin of second wing entire in the female, slightly emarginate in the male, visible along entire dorsal margin of first wing, and produced below anal angle of first wing, extending about two-fifths of the distance across its caudal margin; mesothoracic spiracles with their cephalic margins strongly convex. Length, retracted, 25-35 mm.; expanded, 30-40 mm.; girth, about 50 mm.

Genus **Tropaea** Hübner.

Body usually somewhat depressed; abdominal segments 5 to 7 distinctly tapering, face parts never elevated above the surface of the body; antennæ pectinate throughout, the stem of the flagellum elevated above the level of the pectinations and more than one-third the total width; invaginations for the anterior arms of the tentorium distinct; eye-pieces both visible; clypeo-labral suture distinct; maxillæ, measured on meson, about one-eighth the length of wings; about half the tibiæ and the tarsi of the first pair of legs and the tips of the second pair of legs adjacent on the meson; median line distinct on all thoracic segments; each mesothoracic spiracle about one-fourth the distance along the caudal margin of prothorax to meson; mesothorax with a prominent tubercle at base of wings and a slight depression along lateral margin of alar area; caudal part of mesonotum and metanotum not depressed adjacent to wings; wings with their distal margins not elevated above the surface of the body; abdominal segments 5 to 7 with the lateral aspects of the cephalic margins covered with sharp, slightly wavy, transverse ridges with distinct furrows between, the cephalic margin narrowed on the dorsum, the furrows extending dorsad about two-thirds of the distance between the spiracular line and the meson and ventrad less than half way between the spiracular line and the meson, the furrows usually concealed when the abdomen is retracted; abdominal segments 8 to 10 tapering quickly to form a convex cone-shaped piece; caudal end of body deeply rugose with a slight concavity containing a circular group of strongly recurved spines, the curved tips all pointing toward the center of the group.

This genus is found throughout the Atlantic States and the Mississippi Valley, and includes a single species in this country. The cocoon is ovoid, thin and "papery" on the outside, with a thin inner layer of loose fibers of silk, but it has no opening at the end with loose fibers of silk closing it, as in *Callosamia promethea*. The cocoon is usually brown in color, and is found among the leaves on the ground under the food plant.

Tropaea luna Linnaeus.—Color generally chestnut brown with an irregular white blotch extending between the proximal ends of the antennæ; face parts and exposed portion of thorax with fine indeterminate, impressed lines, the first eight abdominal segments with fine punctures more numerous at the dorsal cephalic portion of segment; antennæ of male tapering gradually until near distal end, then the mesal margin concave to tip, length two and one-half times the width, ending near the middle of exposed portion of tarsus of the second pair of legs; labrum variable, usually broadest on the distal portion, with more than twice the length, five-sided and pointed at the distal end; maxillæ with each half quadrilateral, the median length much less than the greatest width; first wing with its dorsal margin rounded from point of attachment, so that the anal angle is almost impossible to determine; second wing visible around entire dorsal margin of first wing, its margin entire, not produced to form an anal angle and extending about half way across caudal margin of first wing. Length, abdomen retracted, 30-37 mm., expanded, 37-45 mm., girth 38-50 mm.

Genus **Agapema** Neumoegen & Dyar.

Body tapering at cephalic end, abdominal segments 8 to 10 never forming a cone; antennæ pectinate throughout, tapering to a point at the distal end; invaginations for the anterior arms of the tentorium distinct; eye-pieces both visible; labrum elevated above the surrounding surface, clypeo-labral suture obsolete; maxillæ measured on meson about one-seventh the length of wings; median thoracic line distinct on prothorax and mesothorax, sometimes on the metathorax; strongly carinate on prothorax; caudal portion of mesonotum and metanotum slightly depressed at base of wings; wings with their distal margin slightly raised above the dorsal surface of body; lateral aspect of the cephalic margins of abdominal segments 5 to 7 with sharp, slightly wavy, transverse ridges with distinct furrows between, the cephalic margin narrowed on the dorsum and the furrows indistinct, furrows extending ventrad to the region of the proleg scars; cremaster absent; abdominal segments with distinct depressions between the segments, excepting on the dorsum; the tenth segment, as viewed from above, a transverse plate, concave on the caudal margin and the lateral angles produced into lobes, as viewed from ventral aspect, the ventral surface strongly concave and five short, curved spines inserted close together in the lateral margin of each lobe.

This genus includes a single species in North America, *Agapema galbina*, found in Arizona, Texas and Mexico. The pale grayish tan cocoons consist of two layers, a very thin, coarsely reticulated outer layer, and an inner thicker layer with smaller reticulations, both layers having loose fibers at the cephalic end closing an opening made by the thicker walls. It is suspended by the side, as *Samia cecropia*.

Agapema galbina Clemens.—Color generally tawny or yellowish brown, with slightly darker transverse conjunctiva and margins of spiracles; entire surface except wings and antennæ, covered with fine wavy impressed lines and coarse punctures; wings and antennæ with similar lines, but much deeper impressions; face parts elevated; tips of antennæ usually lie adjacent on the meson for a distance nearly equal their width, occasionally separated by the cases for the first pair of legs; length two and one-half times width, stem of the flagellum elevated above the level of the pectinations; labrum slightly longer than broad, its distal end rounded or pointed; maxillæ with each half somewhat triangular in outline, with lateral margins concave, surface almost smooth; space between maxillæ and antennæ filled in by part of the tibia and tarsus of the first pair of legs; mesothoracic spiracles triangular, mesothorax with lateral part of alar area elevated and a smooth, rounded spot about two-thirds of the distance from the cephalic margin; first wing with its anal angle very broadly rounded on cephalic margin of fourth abdominal segment; second wing visible along entire dorsal margin of first wing, its margin entire, produced around angle of first wing, but never reaching half way across its caudal margin; first and second abdominal spiracles often partially covered by the wings. Length, abdomen contracted, from 15-25 mm.; girth, 25 mm.

Genus **Callosamia** Packard.

Body cylindrical; face parts slightly elevated; antennæ pectinate throughout, tapering gradually to a point at the distal end, the stem of the flagellum raised above the level of the pectinations and one-third the total width of the antenna; invaginations for the anterior arms of the tentorium distinct; clypeo-labral suture obsolete; maxillæ, measured on the meson, always about one-sixth the length of the wings, triangular in outline; tarsi of the first pair of legs and tips of the second pair adjacent on the meson; median line distinct on the prothorax and mesothorax; caudal portion of mesonotum and the metanotum depressed adjacent to the wings; wings with their distal margin always raised above the level of the dorsal surface of the body; first pair of wings with their anal angles rounded and opposite the cephalic margin of the fourth abdominal segment; second pair of wings visible along entire dorsal margin of first pair; abdominal segments 8 to 10 tapering rapidly to form a cone; cremaster absent.

This genus includes two species in North America. Both of these, *C. promethea* and *C. angulifera*, are found east of the Mississippi. The cocoons of *C. promethea* resemble those of *P. walkeri*, but are more common, dangling in clusters from almost every spice bush, wild cherry and many other food plants in regions where they occur. Promethea cocoons are grayish brown in color, usually darker than walkeri cocoons and cylindrical in shape, generally blunt at the caudal end. They are suspended by a long band of silk from the cephalic end which usually fastens the encircling leaf to a twig together with the cocoon. *C. angulifera* is comparatively rare and its cocoons are seldom found suspended from twigs, but are usually found among fallen leaves at the base of a tree. They are ovoid, dull brownish gray in color, with the valvular arrangement of loose fibers of silk at one end. The walls of the cocoon are thicker than promethea cocoons and more readily separated into layers.

The following table will serve to separate the pupæ of this genus:

A. Dorsal cephalic margins of abdominal segments 5–7 produced into a flange-like ridge, widest at meson and ending opposite spiracles; spiracular openings at the bottom of a lenticular depression; dorsal margin of second pair of wings scarcely bisinuate. *promethea.*

AA. Dorsal cephalic margins of abdominal segments never produced into a flange-like ridge; spiracular openings with a lenticular, elevated, smooth, rounded margin; dorsal margin of second pair of wings deeply bisinuate. *angulifera.*

Callosamia promethea Drury.—Color generally yellowish, dark brown on the middle of the back and around the margin of spiracles, sometimes on the wings; dorsal aspect of thorax and abdomen with deep, wavy, transverse striations, fine, indeterminate striations on face parts, wings and legs, the remaining surface practically smooth; dorsal cephalic margins of abdominal segments 5–7 produced into flange-like plates, widest at the meson and ending opposite the spiracles; line between segment and transverse conjunctiva elevated on dorsal aspect; tips of antennæ generally separated by second pair of legs, ending in the female half-way between the tips of the first and second pairs of legs, in the male opposite the tips of the second pair, tips of antennæ in both sexes frequently meet on meson, those of male slightly longer and wider than those of female, the length never more than three times width; no eye-pieces visible; labrum variable, broadly rounded distally; maxillæ generally smooth, sometimes separated on meson to show coxal cases beneath, length on meson equals breadth at cephalic end; margin of second pair of wings scarcely bisinuate, produced into a rounded anal angle and extending less than half way across caudal margin of the first pair; mesothoracic spiracles small; first and second abdominal spiracles partially covered by the wings; spiracular openings located at the bottom of lenticular depressions, lips of the depression smooth and glossy, and of the opening, rounded and of a different color; abdominal segments 8–10 taper rapidly to form a cone, occasionally with a button-like tip. Length, abdomen retracted, from 20–30 mm., expanded, 25–35 mm.; girth about 40 mm.

Callosamia angulifera Walker.—Color generally yellowish or yellowish brown, darker brown on the middle of the back and around the margins of spiracles, usually a darker color pattern on wings; dorsal aspect of thorax and abdomen with deep, wavy, transverse striations, fine indeterminate striations on face parts and appendages, the remainder of the surface practically smooth; dorsal cephalic margins of abdominal segments 5–7 never produced into flange-like plates; line between segment and conjunctiva on dorsal aspect elevated and corrugated; antennæ of male meet on meson and lie adjacent to each other for a distance nearly equal to their width, their length three times the width, antennæ of female separated to show first and second pairs of legs, their length three and one-third times width, ending just below first pair of legs; no eye-pieces visible; labrum variable, usually broadly truncate distally; maxillæ with mesal length greater than breadth at cephalic end; margin of the second pair of wings deeply bisinuate, a narrow portion produced below anal angle of first wing and extending less than half way across its caudal margin; first and second abdominal spiracles seldom partially covered by wings; spiracular openings with an elevated, rounded, smooth, lenticular margin, the lips of the openings rounded and pitted; tip of abdomen rounded. Length, abdomen retracted, 20–25 mm., expanded 25–30 mm.; girth, 40 mm.

Genus **Eupackardia** Cockerell.

This genus strongly resembles Callosamia, except for the points indicated in the key. The face parts are slightly elevated; antennæ pectinate throughout, the stem of the flagellum always elevated above the level of the pectinations and about one-third the total width; invaginations for the anterior arms of the tentorium distinct; clypeo-labral suture indicated by a slight furrow; maxillæ measured on the meson one-sixth the length of the wings; tarsi of the first pair of legs and tips of the second pair adjacent on the meson; caudal part of the mesonotum and metanotum depressed adjacent to the wings and strongly wrinkled, the wrinkles extending over the first two abdominal segments; wings with their distal margin always raised above the level of the dorsal surface of the body; first pair of wings with their anal angles rounded and opposite the cephalic margin of the fourth abdominal segment; second pair of wings scarcely visible opposite the second abdominal spiracle, but otherwise entirely visible around the first wing and extending below it on the ventral surface, reaching about half the distance along the caudal margin of the first wing; abdominal segments 8 to 10 tapering rapidly to form a cone-shaped piece; cremaster absent.

This genus includes a single species. *Eupackardia calleta* is reported from Arizona and Mexico. Its cocoon is very firm, flask-shaped, with loose fibers of silk forming a sort of valve across the open cephalic end. It is suspended from a twig by means of a very short band of silk which encircles the twig.

Eupackardia calleta Westwood.—Color generally dull black with a yellowish face-piece; exposed surface of thorax, face-pieces and appendages with fine indeterminate transverse striations, remainder of surface practically smooth; dorsal cephalic margin of abdominal segments 5 to 7 never produced into flange-like plates; never with an elevated line between the segment and the transverse conjunctiva; antennæ of female extends to tips of first pair of legs and length is four times width, in the male they reach to tips of second pair and length is three and one-half times width; glazed eye-pieces visible; labrum variable, generally elevated, pentagonal or shield shaped; maxillae with mesal length and breadth at cephalic end approximately equal; margin of second wing slightly sinuate, produced below anal of front wing to caudal margin of fourth abdominal segment and more than half way across caudal margin of first wing; first and second abdominal spiracles partially covered by the wings; spiracular openings located at the bottom of lenticular depressions, margins of the openings felted; tip of abdomen rounded with ten or more short, rigid spines less than one millimeter long, forming a circular group. Length, abdomen retracted, 25–30 mm., expanded 35–40 mm.; girth about 50 mm.

Genus **Rothschildia** Grote.

Exposed surface of thorax and abdomen sparsely covered with fine setæ; face-parts slightly elevated; antennæ pectinate throughout, tapering gradually to a point at the distal end, length and width varying with the sexes and reaching more than half way between the tips of first and second pairs of legs; antennæ of male elevated, with a depression on each side the stem of the flagellum; antennæ of female with the stem of the flagellum raised above the level of the pectinations; invaginations for the anterior arms of the tentorium indistinct; eye-pieces both visible; clypeo-labral suture generally distinct; maxillæ, measured on meson, about one-fifth the length of wings, triangular in outline, its mesal length greater than the width at proximal end; tarsi of the first pair and tips of the second pair of legs adjacent on the meson; metanotum wrinkled at base of wings but not always depressed; wings with their distal margins raised above the dorsal surface; first wing with its angle on cephalic margin of fourth abdominal segment; second wing visible along dorsal margin of first wing, its margin entire and produced below the anal angle of first wing to the caudal margin of the fourth abdominal segment, extending more than half way across margin of first wing; spiracular line curves ventrad; cremaster wanting; abdominal segments 8–10 bluntly cone-shaped, the caudal end with a band of coarse setæ about one millimeter long, either erect or closely appressed to the body.

This genus consists of two species found in Arizona and southward into Mexico. The cocoons are very firm, those of *R. orizaba* being about two inches long, three-fourths of an inch wide, rather ovoid in shape, usually slightly narrowed and rounded at the ends, while those of *R. jorulla* are vase-shaped, about of the same dimensions with a well defined opening laterally at the cephalic end, showing the valvular arrangement of loose fibers. Both species have very light grayish tan cocoons, those of *R. jorulla* being suspended by a band of silk at the cephalic end. The pupæ of the two species can be separated as follows:

A. Median thoracic line distinct on all segments; caudal part of mesonotum and metanotum depressed at base of wings; distal margin of wings strongly elevated above the dorsal surface of body; setæ on metathorax and first four abdominal segments sparsely distributed, inconspicuous. *orizaba.*

AA. Median thoracic line never distinct on metathorax and often indistinct on mesothorax; caudal part of mesonotum and metanotum not depressed at base of wings; distal margin of wings only slightly elevated above the dorsal surface of the body; setæ numerous on metathorax and first four abdominal segments, conspicuous, at least a millimeter in length. *jorulla.*

Rothschildia orizaba Westwood.—Color generally black with light brown transverse conjunctiva, sometimes abdominal segments 5–10 or 8–10 are light in color; exposed parts of thorax and abdomen sparsely covered with reddish setæ, less than a millimeter long and almost invisible; thoracic segments, face parts and appendages with indeterminate, transverse striations, abdominal segments smooth; antennæ of male with length two and three-fourths times breadth, female with length four times the breadth; face parts curving sharply to the level of the labrum and maxillæ; labrum variable, width about twice length, usually five-sided and slightly elevated above maxillæ; maxillæ, measured on meson, one-sixth the length of wings; median line distinct on all thoracic segments; mesothorax tuberculate at base of wings; caudal part of mesonotum and metanotum strongly depressed adjacent to wings; the distal margin of first wing always considerably elevated above the dorsal surface of body; mesothoracic spiracles slit-like; abdominal spiracles free, second abdominal spiracle one-half the width of its margin away from the wing; caudal end of abdomen with band of stiff, straight setæ, always erect. Length, abdomen retracted, 23–27 mm., expanded, 30–37 mm.; girth about 50 mm.

Rothschildia jorulla Westwood.—Color usually reddish brown; exposed surface of thorax, and usually the face parts, with fine, indeterminate, transverse striations, deeper on the prothorax; abdominal segments 1–4 with minute tubercles, remainder of body surface practically smooth; exposed surface of thorax and abdomen with conspicuous, coarse reddish setæ, most numerous on the first four abdominal segments and sparsely distributed over the remainder; antennæ in both sexes separated by the legs and extending more than half way between the tips of the first and second pairs of legs, length in the male three times the breadth, in the female almost four times the breadth; face parts convex, mostly in the clypeal region; labrum variable, always broader than long and generally with a rounded median lobe; maxillæ, measured on meson, one-sixth the length of wings; median thoracic line distinct on prothorax and part of mesothorax; mesothorax roughened and metanotum longitudinally wrinkled at base of wings, but never noticeably depressed; distal margin of first wing only slightly elevated above dorsal surface of body; abdominal spiracles usually free, second abdominal spiracle adjacent to the wings; caudal end of abdomen with a narrow, transverse band of setæ, sometimes extending on dorsal surface of tenth abdominal segment, either erect or closely appressed to body. Length, retracted, 25–28 mm.; girth about 45 mm.

Genus **Samia** Hübner.

Body cylindrical; face parts slightly elevated; antennæ with the stem of the flagellum raised above the level of the pectinations, in the female the antenna is pectinate throughout, not prominently elevated above the surface of the wings, and tapering gradually to a pointed tip at the distal end, in the male strongly elevated above the surface of the wings, the sides approximately parallel for the greater part of their length and tapering gradually to a blunt, rounded tip at the distal end, the stem of the flagellum often extending beyond the pectinations; a portion of the glazed eye-piece always visible in the female, sometimes in the male; invaginations for the anterior arms of the tentorium distinct; clypeo-labral suture usually distinct; labrum with width always much greater than length; maxillæ, measured on meson, never less than one-fifth the length of wings, triangular in outline, and usually smooth in comparison with the other appendages, occupying a more or less sunken area between the elevated face parts and the first pair of legs; tarsi of the first pair of legs and tips of the second pair of legs adjacent on the meson; median line always very distinct on the prothorax, weak on the mesothorax and sometimes slightly indicated on the metathorax; caudal portion of mesonotum and the metanotum depressed adjacent to the wings; wings with their distal margins always strongly raised above the dorsal surface of the body; first pair of wings with their anal angles rounded and opposite the cephalic margin of the fourth abdominal segment; second pair of wings visible along entire margin of first wing, but usually almost concealed by the first wing on the third abdominal segment and produced around the anal angle of first wing to the caudal margin of the fourth abdominal segment; abdominal segments usually with three rows of tubercle scars on each side the meson, one row situated laterad of the dorsal medial line about one-fourth the distance between the medial line and the spiracular line, the second row on the dorsum about half way between the first row and the spiracular line, the third row on the ventral surface, not quite half way between the spiracular line and the proleg scars; abdominal segments 8–10 tapering rapidly to form a cone.

The genus *Samia* is found in nearly all parts of North America. There are four recognized species in this genus, *S. cecropia*, reported from the entire region east of the Rocky Mountains, *S. gloveri*, from the Rocky Mountain region and Arizona, S. columbia, from the Northern Atlantic States, and *S. californica*, from the Pacific States. The cocoons are always fastened by one side to a twig with fibers of silk; the general shape is oval. Cecropia cocoons are large, the largest found in North America, usually at least three inches long with two distinct layers of silk. There are many different shapes and at least two distinct types of cocoons, those with a very loose, soft outer layer giving the cocoon a "baggy" appearance and those firmer on the outside which are seldom more than an inch in width, often only three-fourths, while the "baggy "ones usually reach a width of two inches or even more. No satisfactory explanation has been given for this variation. The cocoons of the other species are similar to those of *S. cecropia* but smaller and usually firm. The cocoon of *S. gloveri* may usually be recognized by its external coating of white silk, which is spun first by the larva. The other species usually have grayish-tan or brown cocoons. The pupæ of these species may be separated by the following table:

- A. Dorsum of abdominal segments finely deeply rugose, glossy, somewhat resembling velvet; color usually very dark brown or black.
  - B. Ventral row of tubercle scars always present and conspicuous, usually smooth and shining; tubercle scars on the metathorax and first abdominal segment very prominent and often red in color. *gloveri.*
  - BB. Ventral row of tubercle scars never present; tubercle scars on the metathorax and first abdominal segment small and inconspicuous and never red in color. *californica.*
- AA. Dorsum of abdominal segments finely rugose, but not deep enough to give the dull surface a velvety appearance; color usually yellowish or chestnut brown, rarely black.
  - B. Maxillae one-fifth the length of the wings; length normally over one inch. *cecropia.*
  - BB. Maxillae one-fourth the length of the wings; length not over one inch; tubercle scars of the metathorax and first abdominal segments usually prominent, often elevated and tipped with red. *columbia.*

Samia californica Grote.—Color variable, typical specimens black, the caudal abdominal segments often light brown or yellowish and occasional specimens almost entirely yellowish brown; face parts, appendages and exposed surface of the thorax with fine, wavy, indeterminate transverse striations; dorsal abdominal segments 1–8 finely, deeply rugose resembling velvet, glossy in appearance, remainder of surface practically smooth; antennæ of male with the stem of the flagellum about one-fourth the total width of the antenna and with the tips sometimes extending beyond the pectinations; the length of the antenna a little more than twice the width and almost reaching the tips of the second pair of legs, the distal half of each antenna occasionally lying adjacent on the meson; antennæ of female with the stem of the flagellum one-third or more the total width of the antenna, ending opposite the tips of the first pair of legs and slightly shorter in some abnormal specimens, length a little more than three times width; clypeo-labral suture usually distinct; the clypeus not prominently convex cephalad of the labrum; labrum variable, concave on its proximal margin, broadly rounded or slightly pointed at distal end, the width at least twice the length; maxillæ, measured on meson, about one-fourth the length of wings, the mesal length usually greater than the greatest width; third pair of legs often showing between the wings; mesothorax with the alar area slightly polished, never showing a distinct tubercle or tubercle scar; metathorax without distinct tubercles; second pair of wings visible around entire dorsal margin of first pair of wings, and seldom concealed by them on the third abdominal segment, produced below the anal angles of first pair of wings to the caudal margin of the fourth abdominal segment; spiracles usually free, the first and second seldom partially covered by the wings; abdominal segments with the two dorsal rows of tubercle scars generally distinct, but never having the row on the ventral surface between the spiracular line and the proleg scars; abdominal segments 5–7 with their dorsal cephalic margins produced into narrow flange-like plates extending laterad to the spiracular line, with a distinct notch at meson and the median line indicated by oblique striations, also with a raised, wavy line between the segment and the transverse conjunctiva; abdominal segments 8–10 with the caudal end produced into a narrow blunt tip; the scars of the anal prolegs never distinct on each side the anal plate; cremaster absent. Length, abdomen retracted, 30–35 mm., expanded, 40–45 mm.; girth about 50 mm.

Samia cecropia Linnaeus.—(Figs. 8, 9, 10). Color variable, usually chestnut brown with black on thorax and appendages, sometimes yellowish brown, but never entirely black; face parts, appendages, and exposed surface of thorax with fine, indeterminate, transverse striations, dorsal abdominal segments 1–8 finely rugose, but dull in appearance, not resembling velvet, remainder of surface practically smooth; antennæ of male with the stem of the flagellum about one-fourth the total width of the antenna and always extending beyond the pectinations, the length of the antenna about two and one-half times the width and almost reaching the tips of the second pair of legs; antennæ of female with the stem of the flagellum at least one-third the total width, the length of the antenna about three and one-half times the width and never extending as far as the tips of the first pair of legs; clypeo-labral suture generally distinct, clypeus prominently convex cephalad of the labrum; labrum concave on its proximal margin, broadly rounded at distal end, the width more than twice the length; maxillæ, measured on meson, about one-fifth the length of the wings, length and width approximately equal; third pair of legs very rarely showing between the wings; mesothorax with the alar area polished, usually showing a distinct tubercle or tubercle scar; metathorax without distinct tubercles; second pair of wings usually visible around entire dorsal margin of first wing, often almost concealed by first wing on the third abdominal segment and produced below the anal angle of first wing to the caudal margin of the fourth abdominal segment; spiracles usually free, the first and second sometimes partially concealed by the wings; abdominal segments with the three rows of tubercle scars distinct; abdominal segments 5–7 with their dorsal cephalic margins very rarely produced into flange-like plates and these scarcely visible in lateral view, and elevated, longitudinally striate, wavy line between the segment and the transverse conjunctiva; abdominal segments 8–10 with the caudal end seldom produced into a narrow, blunt tip; in ventral view the scars of the anal prolegs usually distinct on each side of the anal plate; cremaster absent. Length, abdomen retracted, 32–35 mm., expanded, 40–45 mm.; girth about 55 mm.

Samia columbia Smith.—Color usually dark brown to blackish; face parts slightly elevated; face parts, exposed surface of thorax and dorsal surface of abdomen with fine, determinate, transverse striations, specially marked on the mesothorax, metathorax and face pieces; antennæ of male with the stem of the flagellum about one-third the total width of the antenna, and not extending beyond the pectinations, the length of the antenna about two and three-quarters times the width, ending opposite the tips of the first pair of legs; clypeo-labral suture usually distinct; clypeal region strongly elevated, mound-like, above the labrum; labrum variable, its proximal margin concave, width at least twice length, the distal margin broadly rounded; maxillæ, measured on meson, one-fourth the length of the wings, its mesal length usually greater than greatest width, the surface polished; third pair of legs very seldom visible between the wings; mesothorax with the alar area longitudinally rugose throughout, appearing somewhat polished to the unaided eye; metathorax with a prominent tubercle on each side the meson, a smaller one near each lateral margin, both tubercles reddish at tip; a similar pair usually present each side the meson on the first abdominal segment; second pair of wings not visible around entire dorsal margin of front wing being covered by the first pair of wings between the first and third abdominal spiracles; abdominal segments with the three rows of tubercle scars present and conspicuous; abdominal segments 5–7 sometimes with indications of a flange-like plate notched at the meson but never extending as far laterad as the spiracular line, the caudal margin scarcely elevated adjacent to the conjunctiva; spiracle of the third abdominal segment and sometimes of the second partially covered by the wings; tip of abdomen usually slightly produced into a blunt tip; the scars of the anal prolegs seldom distinct on each side the anal plate; cremaster absent. Length, abdomen retracted, 23–26 mm., expanded, 26–30 mm.; girth about 35 mm. Described from male specimens only.

Samia gloveri Strecker.—Color variable, usually dark brown to black with traces of yellowish brown; face parts, appendages and exposed surface of thorax with fine, indeterminate transverse striations, abdominal segments finely, deeply rugose, usually velvety in appearance; antennæ of male with the stem of the flagellum about one-fourth the total width of the antenna, the stem of the flagellum projecting slightly beyond the pectinations, and extending almost to the tips of the second pair of legs, the length about two and three-quarters times the breadth; antennæ of female with the stem of the flagellum about one-third the total width of the antenna, extending to the tips of the first pair of legs, the length four times the width; clypeus not prominently convex above the labrum; labrum variable, seldom concave at proximal end and, if concave, only slightly so, width greater than length and broadly curved at distal end; maxillæ, measured on meson, between one-fourth and one-fifth the length of wings, seldom smoother than the other appendages, the median length and greatest width approximately equal; mesothoracic spiracles partially covered by antennæ; mesothorax with alar area polished; second pair of wings never visible around entire dorsal margin of the first pair of wings, but concealed by the first pair of wings between the first and third abdominal spiracles; metathorax without prominent tubercles, a prominent, usually reddish tubercle scar on each side the meson, and a small tubercle near each lateral margin of the metathorax; abdomen with three rows of tubercle scars, conspicuous and polished; cephalic margins of abdominal segments 5–7 with indications of a flange-like plate near the meson, the edges of the segment adjoining the transverse conjunctiva longitudinally ridged but scarcely elevated; first and second abdominal spiracles partially concealed by the wings; abdominal segments 8–10 with the caudal end produced into a narrow blunt tip, in ventral view the scars of the anal prolegs distinct on each side the anal plate; cremaster absent. Length, abdomen retracted, 30–35 mm., expanded, 35–40 mm.; girth, 45–50 mm.

Genus **Philosamia** Grote.

Face parts slightly elevated; antennæ pectinate throughout, tapering gradually to a point at the distal end, the stem of the flagellum distinctly raised above the level of the pectinations and nearly one-third the total width of the antennæ, similar in the sexes; glazed eye-pieces visible in both sexes; invaginations for the anterior arms of the tentorium distinct; clypeo-labral suture indistinct; maxillæ, measured on the meson, about one-third the length of the wings; tips of first and second pairs of legs adjacent on the meson; median thoracic line distinct on all segments; caudal part of mesonotum and metanotum depressed adjacent to wings; wings with their distal margin raised above the dorsal surface of the body; first wing with its anal angle broadly rounded, opposite the second abdominal spiracle; second wing generally visible along the entire dorsal margin of first wing, its margin wavy, produced into a prominent anal angle reaching the caudal margin of the fourth abdominal segment; abdominal segments 8–10 tapering rapidly to form a blunt or truncate cone; cremaster absent.

This genus contains a single species, *Philosamia walkeri*, which is a native of China and was introduced into America from Europe. At first it was confined to the Atlantic Coast States, but is gradually spreading westward. The cocoons are on an average two inches long, half an inch wide and pointed at the caudal end. The cephalic end is open with a valvular arrangement of loose fibers of silk. The cocoons are encased in a leaf and suspended from the twigs by a band of silk spun over the petiole of the leaf holding it to the stem. The cocoons are pale gray or grayish tan in color and closely resemble the cocoons of *C. promethea*.

Philosamia walkeri Felder.—(Fig. 14). Color generally yellowish brown, darker on wings and dorsum; exposed surface of thorax and abdomen with fine, indeterminate, transverse striations; antennæ reaching half way between the tips of the first and second pair of legs; labrum short and broad, its width usually six times the length; maxillæ triangular in outline, lateral margin with the proximal two-thirds concave; abdominal segments with a heavy, raised, slightly wavy line on the dorsal and lateral aspects of the caudal margin, extending ventrad to the proleg scars, a similar line along the cephalic margin ending opposite the spiracles; two dorsal rows of tubercle scars as in *Samia*. Length, abdomen retracted, from 20–30 mm., expanded, 25–35 mm.; girth about 40 mm.

EXPLANATION OF PLATES.

PLATE V.

Fig. 1. Ventral view of a pupa of Automeris io.
Fig. 2. Lateral view of a pupa of Automeris io.
Fig. 3. Ventral view of a pupa of Adelocephala bicolor.
Fig. 4. Ventral view of a pupa of Hemileuca maia.
Fig. 5. Dorsal view of a pupa of Hemileuca maia.
Fig. 6. Ventral view of a pupa of Citheronia regalis.
Fig. 7. Lateral view of a pupa of Citheronia regalis.

PLATE VI.

Fig. 8. Ventral view of a pupa of Samia cecropia.
Fig. 9. Dorsal view of a pupa of Samia cecropia.
Fig. 10. Lateral view of a pupa of Samia cecropia.
Fig. 11. Lateral view of a pupa of Telea polyphemus.
Fig. 12. Wing sclerites of Telea polyphemus showing spines.
Fig. 13. Ventral view of a pupa of Tela polyphemus.
Fig. 14. Ventral view of a pupa of Philosamia walkeri.

ABBREVIATIONS.

al—alar area
ao—anal orifice.
at—antenna.
ax—axillary sclerite.
cl—clypeus.
cm—cephalic margin.
cr—cremaster.
dts—dorsal tubercle scar.
dlts—dorso-lateral tubercle scar.
ge—glazed eye.
go—genital orifice.
l—leg.
lb—labrum.
md—mandible.
mn—mesonotum.
ms—mesothorax.
mt—metathorax.
mx—maxillæ.
ps—proleg scar.
pt—prothorax.
s—segment.
se—sculptured eye.
sp—spiracle.
spi—spine.
t—tubercle.
tc—transverse conjunctiva.
vts—ventral tubercle scar.
w—wing.
wt—wing tubercle.